THE ANDREW & ERNA VITERBI FACULTY OF ELECTRICAL ENGINEERING

SIPL
Signal and Image Processing Lab

TECHNION Israel Institute of Technology

Gaming Audio Simulator

In memory of Yael-Haya Azran

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Introduction

- Unreal Engine is an advanced 3D real-time engine used in movies and video games industries.
- Steam Audio is a plugin for Unreal, providing physically-accurate sound for immersive VR experiences
- Simulating room acoustics and producing high-quality and physically accurate sound samples is a necessary ability in both signal processing and machine learning fields.
- Tools currently offered are non-dynamic, complex to use and rely heavily on the user's coding skills.

UNREAL ENGINE + STEAM AUDIO

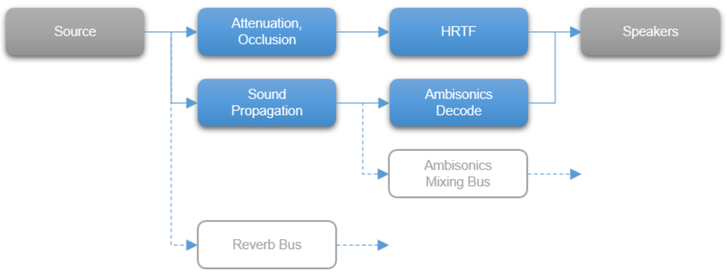
Goals

- Develop a real-time room acoustics simulator:
  - Changing room dimensions and material
  - Add multiple sound sources and microphones and control their location and orientation in the scene.
  - Sound sources can play wav files provided by the user.
  - The sound produced will be calculated in real-time, including sound phenomena such as occlusion, diffraction, attenuation, reflection and more.

Challenges

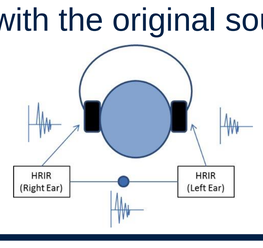
- Sound must be calculated dynamically and change with respect to the room attributes, as well as sound sources and microphone locations.
- Unreal Engine is highly complex
- Most sound solutions does not allow changes to the environment in real-time.
- The simulator is unique and thus, had to be designed and developed from scratch

Producing The Sound



Steam Audio Pipeline

- The engine provides Steam Audio with the current scene data
- Steam calculates RIR for each of the active microphone's "ears" and runs a multi-channel convolution with the original sound wave.

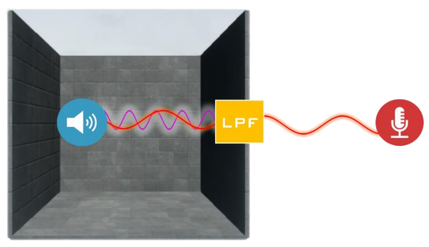


Acoustic Material

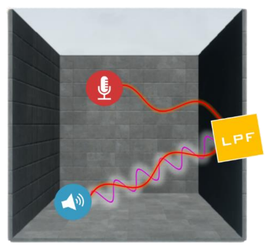
- Defines how sound is heard after it interacts with the room's walls.
- Three frequency bands defined by center frequencies:

Low	Mid	High
800 Hz	4 KHz	15 KHz

- For each of the bands, set absorption and transmission.

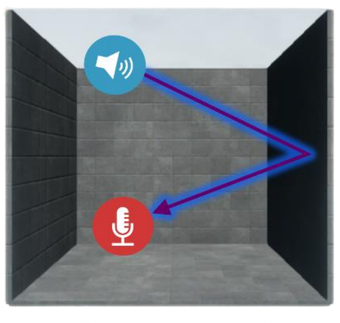


transmission

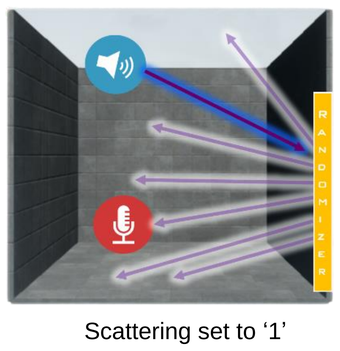


absorption

- Setting the scattering coefficient of the material determines how the material reflects the sound.



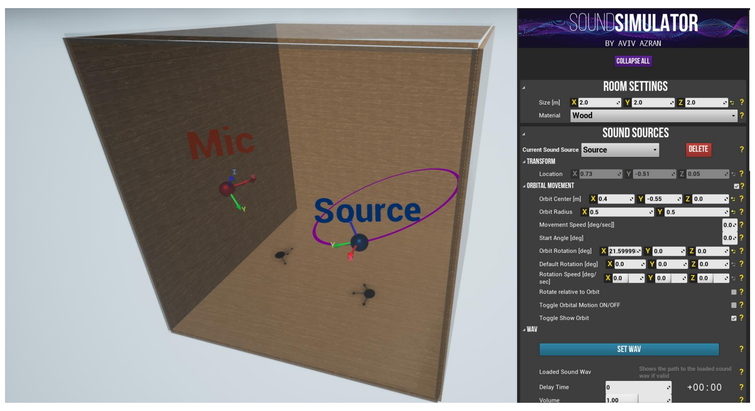
Scattering set to '0'



Scattering set to '1'

Orbital Motion

- Sound objects can be configured to perform orbital motion during the simulation
  - Angular velocity
  - Starting angle
  - Orbit center and orientation
  - Object rotation while orbiting



Orbital motion settings for sound objects in the simulator

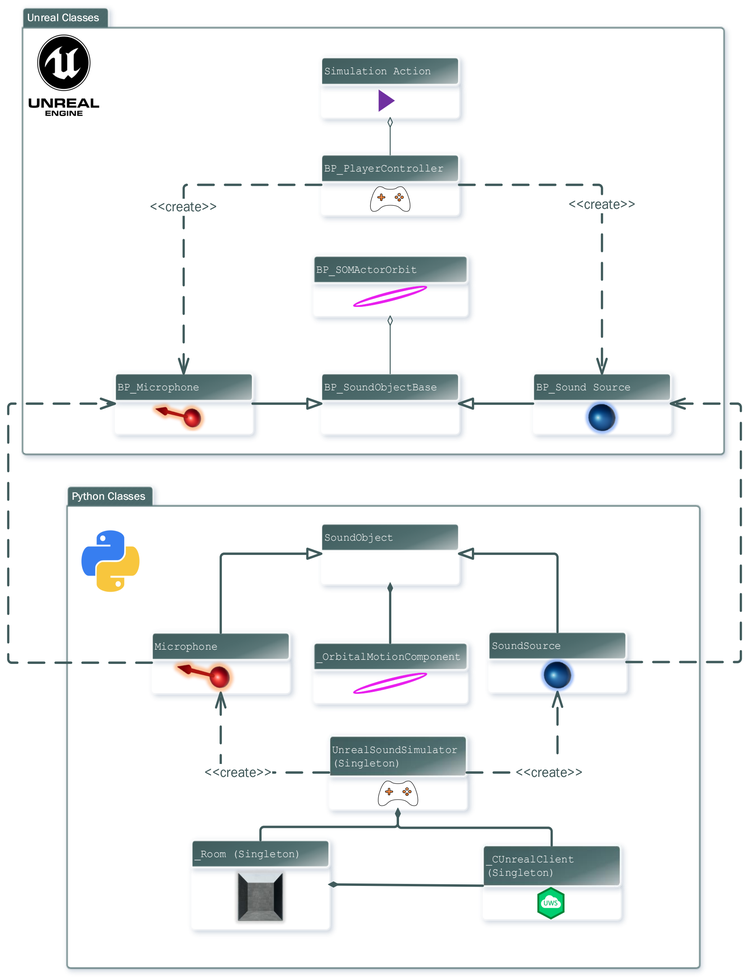
Global Sound Settings

- Speed of sound - User can change the speed of sound to simulate sound propagation in material such as water
- Physics based attenuation – physics-based distance attenuation (inverse distance falloff) is applied to the audio.
- Direct occlusion method – choosing between partial and ray-cast to reduce computational overhead on slower machines
- Air absorption – whether to take air absorption into account when calculating sound.

github.com/avivazran/SOUNDSIMULATOR

Software Structure

Simulator building blocks



UML diagram

- Programmed using OOP principles for modularity and expansion ability.
- Fully supports programmatic control via Python.

Results

- Sound produced by the simulator is highly realistic. provides the user with a sense of localization and of the size and material of the room.
- Simulating reflections up to 3rd order.
- Sound dynamically changes as the room attributes changes with respect to microphones position relative to the sound sources and its location and orientation in the room.
- The user can control the realism level of the direct occlusion by choosing whether to calculate transmission for each frequency band separately or for all of them together.

Conclusions

- The simulator has provided all requested functionality and beyond.
- Using game engines for realistic simulation has been proved to be beneficial for academic research
- As both Unreal Engine and Steam Audio are updated frequently, catching up with new capabilities provided by the developers may lay foundations to follow-up projects, expanding the simulator even further.

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